

TROPHIC STRUCTURE OF BIRD COMMUNITIES IN FOREST PATCHES IN EAST-CENTRAL ILLINOIS

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Consideration of the trophic structure of avian communities (e.g., Willson 1974, Terborgh 1977, Faaborg 1982) provides information on community structure and organization that simple analyses of species richness, diversity, and density do not. Trophic structure reflects, at least in part, the importance of various food resources and variation in trophic structure may therefore reflect variation in availability of food resources among communities.

Trophic structure of avian communities has been studied by many researchers (e.g., Pearson 1975, Karr 1980, Landres and MacMahon 1980, Wagner 1981, Blake 1982), but only Martin (1980, 1981) has applied the concept to bird communities found in isolated patches of forest ("forest islands"). Instead, the relationship between area and species richness has been the focus of most forest island studies (e.g., Moore and Hooper 1975; Galli et al. 1976; Whitcomb et al. 1977, 1981). Forest islands differ in size and vegetation composition, factors that are likely to influence variety and quantity of food resources (Ghiselin 1977; Muhlenburg et al. 1977a, b; Jaenike 1978; Ranney et al. 1981). As a consequence, species richness and abundance of individuals within different trophic assemblages may differ in their relationship to forest size and structure (Martin 1980, 1981). Analysis of trophic structure and, in particular, how different groups vary in response to area, may provide a more complete understanding of the factors that govern overall community structure.

In the following discussion I examine the distribution of species and individuals among different trophic groups found in isolated patches of forest in east-central Illinois. Total species richness and abundance of individuals was strongly correlated with forest area, but the relationship differed among the various trophic groups. Ecological generalists were more abundant in small forests; many used habitat outside forest boundaries for foraging. More specialized species, including many foliage and bark gleaning insectivores, were poorly represented in small forests but were more abundant in large forests.

METHODS

I studied breeding bird communities in 15 forest tracts ranging in size from 1.8–600 ha in east-central Illinois. Thirteen tracts were censused in 1979, 14 in 1980, and six in 1981. All tracts possessed a mature canopy and well-developed understory, and did not show evidence of recent, heavy disturbance. With the exception of a minor amount of edge clearing that

occurred on several sites during winter 1979–80, forests were not disturbed during this study. Large tracts of forest (i.e., over 100 ha) are rare in east-central Illinois and are associated with rivers in almost all cases. As a consequence, both upland and bottomland forest occurred on some study areas.

Birds were surveyed using the point-count technique (Ferry and Frochot 1970, Robbins 1978). Within each forest, one or more study sites were established (hereafter, study area refers to an entire forest tract and study site to a specific census area within the forest). Forest tracts smaller than 20 ha contained a single study site; tracts larger than 20 ha were subdivided into two or more sites. Study sites were located in both edge and interior sections of large forests. Areas containing both bottomland and upland habitat had study sites in each. Within each study site, two or more observation points, ca. 150 m apart, were selected so that the entire study site was covered as thoroughly as possible.

Censuses were conducted from 30 min before sunrise to 2.5 h after sunrise, with two study sites surveyed each morning. Each observation point was visited for 15 min per census. Each 15-min period was divided into three 5-min segments, during each of which all birds seen, or heard were recorded. Birds flying above the canopy, raptors, and nocturnal species were not included. Singing males, family groups, and nests of all other species were counted as one pair; all other observations of single birds were counted as one-half pair. Scientific names of all species recorded are in the Appendix.

The point-count technique does not provide estimates of absolute density (pairs/ha) but it does provide data for comparison of relative levels of bird activity or abundance. Abundance for a study area or site was expressed as the sum of maximum recorded abundance of individual species at all points, divided by the number of points within the study area or site. The value for abundance thus gives average maximum number of individuals observed per point and allows comparison of observable levels of bird activity. Abundances of individual species were used to determine abundance within trophic groups.

Species were divided into trophic groups, including omnivore, granivore, ground, bark, foliage, and aerial insectivore, and nectarivore-frugivore. Classifications were based on primary food type and foraging location using personal observations and data from the literature (Martin et al. 1951, Willson 1974).

Area relationships were examined by linear regression using an exponential model: $S = k \ln A + c$, where S is number of species or individuals within a trophic group, A is forest area (in ha), and k and c are fitted constants. I use the exponential model rather than the power function ($\ln S = z \ln A + \ln c$) because the former model explained a greater proportion of variance in community composition (Blake 1983). Species richness and abundances were tested for normality (Shapiro-Wilks test, Barr et al. 1979) and with one exception, no data sets showed a significant departure from normality. Distribution of aerial insectivore richness values was not normal ($P < 0.05$) and tests of significance were not applied.

As species richness increases, the number of species within trophic groups is expected to increase simply as a function of species richness. Therefore, I compared the observed distribution of species within trophic groups to the distribution expected by chance. I generated a series of randomly assembled sets of species, using the total pool of species recorded from forest islands. For each species richness value (5, 10, 15, . . . , 40), 10 sets of species were drawn with no species included more than once in a single draw. Distribution of species among trophic groups within these randomly assembled communities was then compared to observed distributions (binomial probability test, Sokal and Rohlf 1981).

RESULTS

Species richness within trophic groups.—Only nectarivore-frugivore (two species) and granivore (two species) groups contained fewer than three

TABLE 1
 NUMBER OF SPECIES (SP) AND ABUNDANCE OF INDIVIDUALS (IND, IN PAIRS/OBS. POINT)
 IN THE FIVE MAJOR TROPHIC GROUPS IN EAST-CENTRAL ILLINOIS FORESTS, AVERAGED
 OVER 3 YEARS—1979–1981

Area	Size (ha)	Omnivores		Bark insects		Ground insects		Foliage insects		Aerial insects	
		SP	IND	SP	IND	SP	IND	SP	IND	SP	IND
1	1.8	5.3	9.6	1.3	0.8	1.0	0.9	0.3	0.3	1.7	1.7
2	2.3	4.5	6.2	2.0	1.1	2.5	2.4	3.0	3.4	2.0	3.0
3 ^a	4.7	7.0	12.2	6.0	6.0	4.0	4.2	3.0	3.0	2.0	3.0
4	5.1	6.5	8.2	2.0	1.1	3.5	3.4	2.5	3.6	2.0	2.6
5	6.5	6.5	9.5	3.0	2.5	3.0	3.9	3.5	4.4	2.0	3.0
6 ^a	9.0	3.0	4.0	4.0	4.0	5.0	6.0	3.0	3.0	2.0	2.0
7	16.2	6.0	6.9	3.5	1.8	3.0	3.1	3.0	4.6	2.0	2.2
8	24	7.3	9.4	4.3	2.5	4.3	5.0	6.0	5.5	2.7	2.5
9	24	7.0	8.0	4.3	2.6	4.0	6.8	6.0	4.3	2.3	2.4
10	28	8.3	8.4	7.3	6.1	4.7	3.7	7.0	5.5	2.0	3.2
11 ^{a,b}	40	8.0	12.8	6.0	7.4	4.0	2.4	10.0	9.4	3.0	3.9
12	65	8.0	7.8	7.0	5.8	5.0	3.6	7.5	4.4	3.0	2.6
13	65	7.7	5.8	7.0	5.8	5.0	4.5	8.3	5.0	2.7	3.1
14	118	7.5	6.2	6.5	4.6	5.5	5.6	8.5	6.2	3.0	3.2
15	600	8.7	8.3	8.0	6.4	6.0	4.2	12.0	7.9	3.7	3.8

^a Censused only in 1 year; not included in regression analyses (Table 2).

^b Bottomland forest habitat only.

species. Neither group was represented by many individuals in any year and I have focused attention on the number of species and individuals within the remaining five groups (Table 1).

All five major trophic groups were represented by at least one species on all study areas in 1979 but not in 1980 or 1981, when foliage insectivores were absent from the smallest tract. Dominant groups (i.e., those represented by the most species or individuals) varied among areas. Omnivores were dominant on all areas less than 28 ha in 1979. However, because the number of omnivores did not vary greatly among areas (5–8 species, Table 1), percentage representation of this group decreased with area (Fig. 1). By contrast, both foliage and bark insectivores increased in species richness with area, with the increase especially great for foliage insectivores (Fig. 1). Thus, as forest size increased, community composition changed from omnivore dominated to foliage insectivore dominated in 1979.

More omnivores were recorded in 1980 than in 1979, but numbers of species in all other groups remained unchanged (Table 1). As a consequence, there was not a clear change in 1980 from omnivore dominated to foliage insectivore dominated communities as area increased (Fig. 1).

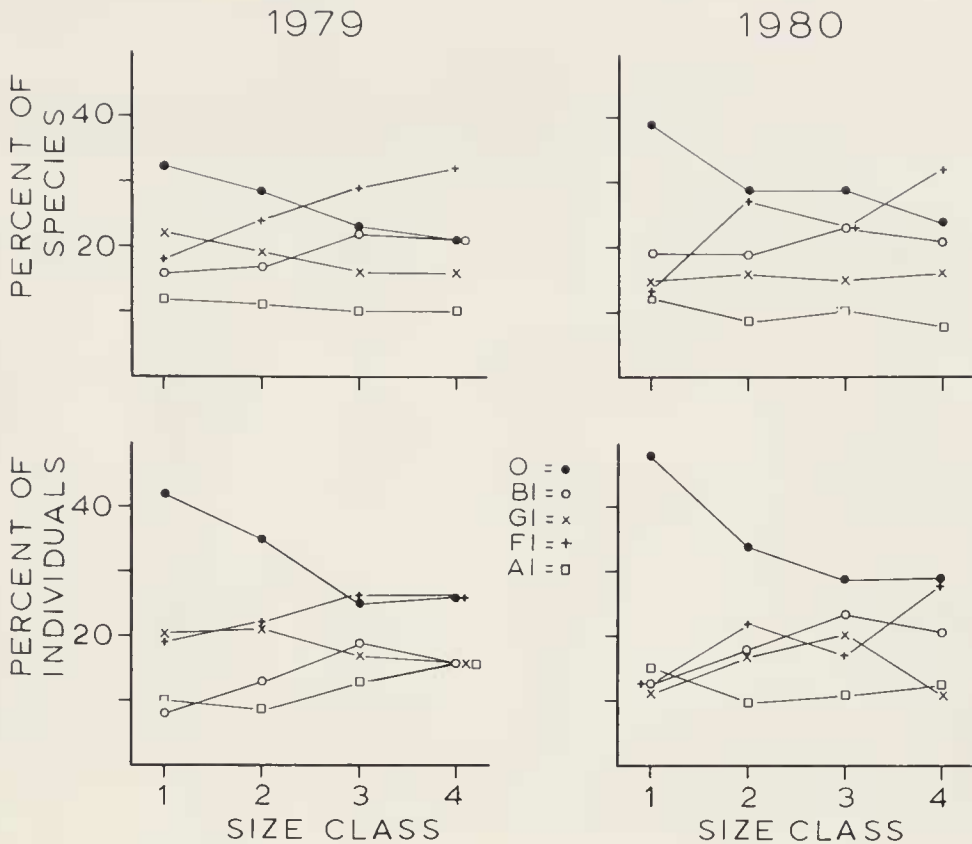


FIG. 1. Composition of breeding bird communities based on abundance of individuals and number of species within five major trophic groups. Size classes of forests are: 1 = 1.8–16.2 ha; 2 = 24–40 ha; 3 = 65–118 ha; and 4 = 600 ha. O = omnivores; BI, GI, FI, and AI = bark, ground, foliage, and aerial insectivores, respectively.

However, percentage representation by omnivores was still highest at the smallest area and lowest at the largest forest (Fig. 1).

Patterns in 1981 were most similar to 1979. (Only six areas were censused and results are not shown graphically.) Fewer foliage insectivores were recorded, but larger areas were still dominated by this group.

Species richness within the five major trophic groups was significantly correlated with area in all years (Table 2). Foliage insectivores are predominantly long-distance migrants, many of which prefer large forest tracts for breeding (Whitcomb et al. 1981) and species richness within this group increased strongly with area. The rate of increase (slope) in bark insectivore richness with area also was high (Table 2). The importance of area for these two groups was further demonstrated by intercept values that did not differ from zero (Table 2), indicating that very small patches of forest were unsuitable for members of these groups. By contrast, ground insectivores, which also were strongly correlated with area, had a higher intercept, indicating that a number of species were not restricted by area

TABLE 2
RELATIONSHIP BETWEEN AREA (LN) AND NUMBER OF SPECIES AND INDIVIDUALS (PAIRS/POINT) IN MAJOR TROPHIC GROUPS; RESULTS AVERAGED OVER 3 YEARS, 1979–1981: ONLY AREAS CENSUSED IN 2 OR 3 YEARS ARE INCLUDED (N = 12)

Trophic group	Slope	Intercept	R	P <
Species richness				
Omnivores	0.65	5.0	0.875	0.001
Bark insectivores	1.29	0.7	0.917	0.001
Ground insectivores	0.79	1.5	0.933	0.001
Foliage insectivores	1.87	-0.1	0.962	0.001
Aerial insectivores ^a	0.32	1.4	0.913	—
Abundance of individuals				
Omnivores	-0.20	8.5	-0.250	NS
Bark insectivores	1.10	0.1	0.856	0.001
Ground insectivores ^b	0.52	2.3	0.582	0.05
Foliage insectivores	0.94	1.7	0.868	0.001
Aerial insectivores	0.21	2.1	0.647	0.05

^a Distribution of values not normal, significance value omitted.

^b Ground insectivore abundance was not correlated with area in any one year.

of forest habitat. Flycatching or aerial insectivores were few in number and showed little increase in species richness with area (Table 2). Omnivores displayed the weakest correlation with area and had the highest intercept in all years. The high intercept reflects dominance of omnivores in small forests and also indicates that many species were not restricted to large tracts of forest.

Increased species richness within larger forests is at least partially due to spatial segregation of species; not all species occur within the same section (study site) of a forest that occur within the entire forest (study area). Data from study sites partially reflect spatial segregation of species and can be used to compare species richness within subsections of a series of forests as total forest area increases. In this study, patterns observed among study areas generally held among study sites, although correlations and slopes generally were lower. The relationship between aerial insectivores and area differed least between study areas and sites. Bark and foliage insectivores remained strongly correlated with area, but with reduced rates of increase. Species richness in omnivore and ground insectivore groups was not correlated with area among study sites.

As species richness in forests increases, species richness within major trophic groups also should increase. I compared observed species richness in trophic groups to that expected from randomly assembled species groups.

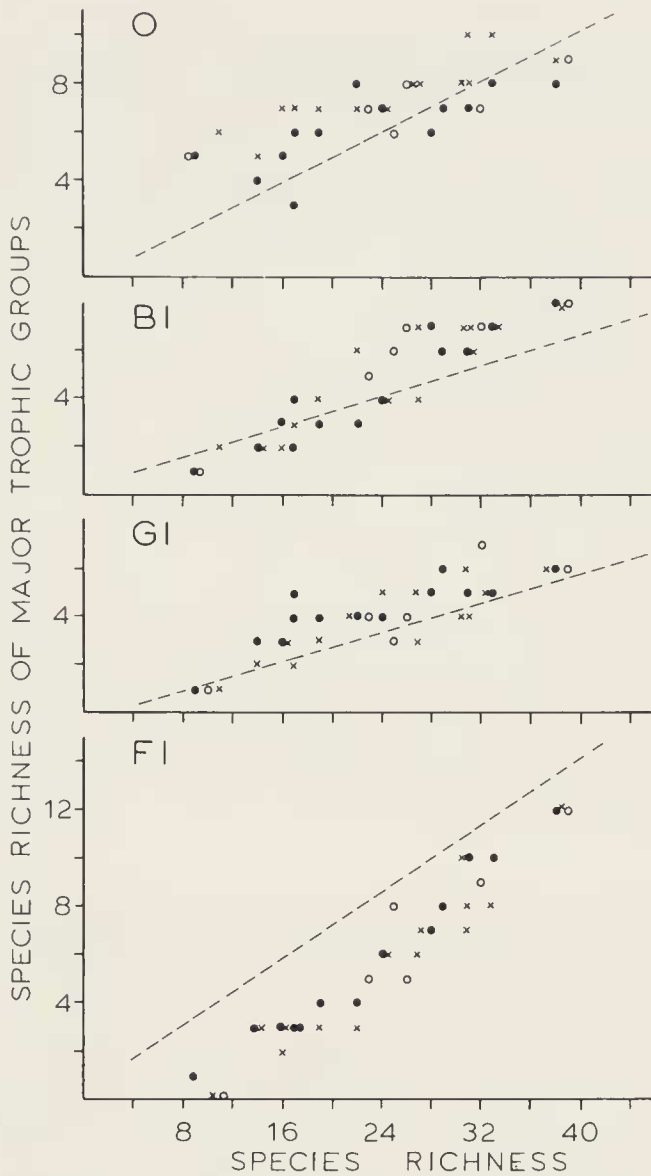


FIG. 2. Species richness of major trophic groups plotted as a function of total species richness. Dashed lines represent the relationship between total species richness and species richness in major trophic groups within randomly generated communities. 1979—closed circles; 1980—x's; and 1981—open circles. O = omnivores; BI, GI, and FI = bark, ground, and foliage insectivores, respectively.

(Aerial insectivores were not considered in this fashion because of low species richness.) Previous studies from New Jersey (Galli et al. 1976) and Illinois (Blake 1983) have indicated that the rate of increase in species richness with area begins to level off at approximately 20–24 ha. In Illinois forests, areas smaller than 20 ha ranged from 2–16 ha and, with one exception (area 3, 4.7 ha), supported fewer than 20 species. Forests >20 ha ranged from 24–600 ha and all supported more than 20 species. (Area 3 was connected by a hedgerow to a larger forest and had a higher than

expected species total [Blake 1983].) I divided forests into those with fewer than 20 species and those with more than 20 species. I then compared distribution of points above and below the regression line for random assemblages for all forests and, separately, for forests with less than and more than 20 species, "small" and "large" forests, respectively.

Omnivores were, overall, more common than expected over the entire range of areas ($P < 0.02$) (Fig. 2). However, when small and large forests were examined separately, omnivore richness was higher than expected in small tracts ($P < 0.003$) but not in large tracts ($P = 0.14$). Apparently, many omnivores are attracted to small forests, perhaps as a consequence of the greater proportion of available edge habitat and the accessibility of surrounding habitat for additional foraging.

More bark insectivore species were present than expected ($P < 0.04$) over the entire range of islands and in large forests ($P < 0.003$), but not in small forests ($P = 0.12$). Ground insectivores were more common than expected over all size classes ($P < 0.001$), in large forests ($P < 0.03$), and non-significantly ($P < 0.10$) in small forests (Fig. 2). Foliage insectivores displayed the greatest deviation from expected. In no case was observed species richness greater than expected based on random assemblages ($P < 0.001$) (Fig. 2).

Distribution of species richness patterns in trophic groups is not independent because the total species pool was divided into relatively few groups. Thus, if one group appears under-represented at one area, some other group(s) must be over-represented. However, the consistency of the patterns argues for their validity. Trophic groups are not represented in all islands simply according to their contribution to the total species pool.

Abundance of individuals within trophic groups.—Based on abundance of individuals, larger areas were not dominated by foliage insectivores to the same extent that they were when species richness was considered (Table 1, Fig. 1). Omnivores showed a slight tendency to decrease in total numbers with increasing area, but the decline was not great. Omnivores not only remained numerically dominant on smaller areas (Table 1), but also were usually the most abundant group on all areas. Percentage representation declined as area increased (Fig. 1), due to increases in other trophic groups.

Correlations between area and abundance within trophic groups generally were not as high as correlations between area and species richness (Table 2). Bark and foliage insectivores were most strongly correlated with area; intercepts were low and not different from zero. The rate of increase (slope) in abundance was approximately the same for both groups. As area increased, bark insectivores added individuals at approximately the same rate as species, but this was not true for foliage insectivores. As a result,

average abundance per species within the latter group decreased ($P < 0.05$) with increasing area. Of the remaining groups, only aerial insectivores were significantly associated with area in a single year and only in 1979. As a consequence, increased abundance in forests was primarily due to increased numbers of bark and foliage insectivores with some increase in aerial insectivore abundance. With all years combined, ground insectivore abundance was significantly correlated ($P < 0.05$) with area (Table 2), but correlation with area was not significant in any single year.

Patterns generally were similar among study sites. Aerial insectivore abundance was significantly correlated with area in 1979 and 1980. Unlike species richness, rates of increase in abundance within trophic groups were not generally less among study sites when compared to study areas.

DISCUSSION

Bird communities within small patches of forest are not random subsets of all species that commonly breed in forests (Galli et al. 1976, Whitcomb et al. 1981); many species are restricted to forests that exceed some minimum area requirement. The influence of area on patterns of species distribution also is apparent when bird communities are examined from a trophic standpoint.

Small patches of forest consist largely of edge habitat (Forman and Godron 1981) and are dominated by birds that feed on a wide variety of food items both within the forest and in surrounding fields (Galli et al. 1976, Martin 1981, Whitcomb et al. 1981), illustrating a major difference between habitat islands and oceanic islands. Many omnivores and ground insectivores are short-distance migrants that winter north of the tropics. Many do not require large tracts of forest for breeding and many species present in small forest tracts are more typically found in thickets and second growth. Such species may occur in small forests because of their ability to forage outside actual forest boundaries. As a consequence, habitat surrounding forest islands may have a strong impact on the distribution and abundance of species and guilds within the island.

Forest edges may support a greater diversity and abundance of food than does forest interior habitat because of their high levels of productivity (Ranney et al. 1981). Species that prefer edge habitat do better in such areas than species more restricted in foraging behavior. In addition, species that are unable to supplement their diet by foraging in surrounding habitat may be influenced to a greater extent by competition or resource limitation. This may be particularly true if the more adaptable species are numerous enough to cause local resource depletion.

Species that glean insects from foliage generally were restricted in distribution among forests. Over the entire range of areas censused, foliage

insectivores were less common than expected, suggesting that some factor(s) limited occurrence of some species. Many foliage insectivores were long-distance migrants that winter in Central and South America. Neotropical migrants, as a group, have been most severely affected by forest reduction and fragmentation (Lynch and Whitcomb 1978, Keast and Morton 1980, Whitcomb et al. 1981). The apparently greater susceptibility of Neotropical migrants to population reduction following forest loss may be a consequence of several life history traits typically associated with long-distance migration (Whitcomb et al. 1981). For example, Neotropical migrants frequently construct open nests in low vegetation or on the ground and such nest-sites may be particularly susceptible to predation (Best 1978, Gates and Gysel 1978, Willis and Eisenmann 1979, Loiselle and Hoppes 1983) or parasitism by the Brown-headed Cowbird (Mayfield 1977, Payne 1977, Gates and Gysel 1978).

Low species richness in small forests may be a consequence, at least partially, of higher predation or parasitism rates (Lynch and Whitcomb 1978, Robbins 1979, Whitcomb et al. 1981) than those characteristic of large forests. If species characteristic of different trophic groups differed in overall susceptibility to predation, then observed differences in distribution patterns among trophic groups might be related to differences in predation and parasitism. Many foliage insectivores are Neotropical migrants that build open cup nests and the apparent paucity of foliage insectivores in small forests may therefore reflect high predation pressures. However, most omnivores, including both long-distance and short-distance migrants, also nest close to the ground in open cut nests and are not scarce in small forest tracts. Further, all bark insectivores nest in tree cavities (or beneath bark, Brown Creeper) well above the ground. However, bark insectivores were not abundant in small forests. (The scarcity of cavity nesters may be due to a shortage of available nest-sites [e.g., von Haartman 1956], but insufficient data are available to examine the possibility.) Increased nest predation and parasitism may influence bird communities in small forests, but it is not immediately apparent that trophic groups should be differentially affected.

Abundance and diversity of food resources also may influence distribution of species and individuals. There is some evidence that diversity and abundance of insects may be related to area (Muhlenberg et al. 1977a, b; Faeth and Kane 1978; Jaenike 1978) and it is possible that resource limitation may be partially responsible for the scarcity of foliage insectivores in small forests. Because most foliage insectivores largely depend on resources available within forest boundaries, the potential for resource limitation may be greater than for species that frequently forage in non-forest habitat (e.g., many ground insectivores, omnivores). If resources

are scarce, competitive interactions among foliage insectivores may influence observed distribution patterns. Previous studies have indicated that competitive interactions, both intra- and inter-specific, may be important among foliage insectivores (e.g., Morse 1967, 1970, 1974; Cody and Walter 1976; Catchpole 1978; Robinson 1981).

Bark insectivores were present over the entire range of areas censused; both Red-headed and Downy woodpeckers were recorded from the smallest area in 2 of the 3 years censused. The Red-headed Woodpecker uses a wider variety of food and foraging behaviors than other bark insectivores, frequently feeding on the ground in surrounding fields (pers. obs.). Greater plasticity in behavior may partially account for its occurrence in small forests. By contrast, Red-bellied Woodpeckers and especially Hairy Woodpeckers generally were confined to larger forests. Although large territory requirements (Graber et al. 1977) were likely partially responsible for the distribution patterns, competitive interactions, primarily with the Red-headed Woodpecker (Graber et al. 1977; Williams and Batzli 1979a, b), also may have influenced occurrence of Red-bellied and Hairy woodpeckers and other bark gleaners (e.g., White-breasted Nuthatch). The Hairy Woodpecker is generally uncommon in east-central Illinois and its numbers have been declining over the past decades (Graber et al. 1977). The decline may be related to concurrent losses of forest cover and increased isolation of remaining tracts of woods.

Previous studies of bird communities in relatively large habitat islands (Galli et al. [1976]—New Jersey; Whitcomb et al. [1981]—Maryland) have not dealt with trophic structure in any detail. Although similarities exist, important differences also are apparent. In all three regions, foliage and bark insectivores were most abundant in large forests and showed the greatest change in species richness from small to large forests. In addition, omnivores were the most abundant group in small forests and declined in relative importance as forest size increased. Abundance of omnivores in small forests may reflect the disturbed nature of such forests and parallels trends in fish communities, where disturbed habitats also are characterized by an increased abundance of omnivorous species (Karr 1981, Schlosser 1982).

Small (under 20 ha) Illinois forests supported few foliage insectivores or bark insectivores. By contrast, small forests in New Jersey and Maryland had approximately twice as many species in each trophic group. Species richness in other trophic groups did not differ as much among the three areas. Forests in the eastern states are less isolated than forests in Illinois and more non-agricultural habitat is available around and between forest patches. As a consequence, some species may be able to incorporate habitat adjoining forest patches in their foraging area. Resource levels

(e.g., insect abundance and diversity) within and immediately adjacent to forest patches also may be influenced by differences in farming practices between Illinois and more eastern states with consequent impacts on bird community structure.

Trophic composition of an island community may be influenced by a variety of factors, but an underlying factor is distribution, variety, and abundance of food resources. Islands that do not differ in structural and habitat features may support a similar resource base with similar consequences on consumer distribution and abundance. Habitat islands such as forest patches are not self-contained units to the same extent that true oceanic islands are. Biotic exchanges between the habitat patch and the surrounding matrix may have a large impact on the community associated with the island or refuge (Kushlan 1979, Forman and Godron 1981). The composition and structure of surrounding landscape can influence the community structure, including trophic structure, of habitat islands to a greater extent than is true for real islands. Thus, analyses of habitat island communities should include consideration of regional patterns of habitat structure.

SUMMARY

Trophic structure of breeding bird communities in isolated forests (1.8–600 ha) in east-central Illinois was studied 1979–1981. Breeding species were assigned to one of seven trophic groups; two groups (nectarivore-frugivore, granivore) were represented by few species or individuals. Abundance and species richness within the remaining five groups varied with forest area and appeared tied to the size and structure of the forest itself and to the composition of the surrounding landscape.

Small forests were dominated by omnivores that frequently foraged in surrounding farmland. Foliage insectivores, primarily Neotropical migrants, were uncommon in smaller forests, but comprised the largest component of bird communities in large forests. Species totals in major trophic groups were significantly correlated with area in all years. Highest correlations were observed for foliage insectivores and bark insectivores. The former group had the highest slope, indicating the most rapid increase in species number with area, a reflection of the increase in number of long-distance migrants in larger forests. Correlation with area generally was not as high for abundance of individuals within trophic groups. However, abundances of both foliage and bark insectivores were strongly correlated with area.

Over the size range of forests covered, distribution of species within major trophic groups differed from that expected if species occurrences were independent of forest area. Omnivores were more common than expected in small forests, whereas ground insectivores and bark insectivores were more common than expected in large forests. Foliage insectivores were underrepresented over the entire range of forest size. Thus, trophic groups were not represented in all forests simply according to their contribution to the total species pool, suggesting that abundance of different food resources varied in dissimilar ways with forest area.

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APPENDIX

BIRD SPECIES RECORDED FROM FOREST TRACTS IN EAST-CENTRAL ILLINOIS DURING BREEDING SEASONS, 1979–1981

Species	Trophic group ^a
Mourning Dove (<i>Zenaida macroura</i>)	G
Yellow-billed Cuckoo (<i>Coccyzus americanus</i>)	FI
Black-billed Cuckoo (<i>C. erythrophthalmus</i>)	FI
Ruby-throated Hummingbird (<i>Archilochus colubris</i>)	N-F
Northern Flicker (<i>Colaptes auratus</i>)	G1
Red-bellied Woodpecker (<i>Melanerpes carolinus</i>)	B1
Red-headed Woodpecker (<i>M. erythrocephalus</i>)	B1
Hairy Woodpecker (<i>Picoides villosus</i>)	B1
Downy Woodpecker (<i>P. pubescens</i>)	B1
Great Crested Flycatcher (<i>Myiarchus crinitus</i>)	A1
Acadian Flycatcher (<i>Empidonax virescens</i>)	A1
Eastern Wood-Pewee (<i>Contopus virens</i>)	A1
Blue Jay (<i>Cyanocitta cristata</i>)	O
Black-capped Chickadee (<i>Parus atricapillus</i>)	B1
Tufted Titmouse (<i>P. bicolor</i>)	B1
White-breasted Nuthatch (<i>Sitta carolinensis</i>)	B1

APPENDIX
CONTINUED

Species	Trophic group ^a
Brown Creeper (<i>Certhia americana</i>)	BI
House Wren (<i>Troglodytes aedon</i>)	FI
Gray Catbird (<i>Dumetella carolinensis</i>)	FI
Brown Thrasher (<i>Toxostoma rufum</i>)	GI
American Robin (<i>Turdus migratorius</i>)	GI
Wood Thrush (<i>Hylocichla mustelina</i>)	GI
Veery (<i>Catharus fuscescens</i>)	GI
Blue-gray Gnatcatcher (<i>Polioptila caerulea</i>)	FI
Cedar Waxwing (<i>Bombycilla cedrorum</i>)	N-F
European Starling (<i>Sturnus vulgaris</i>)	O
Yellow-throated Vireo (<i>Vireo flavifrons</i>)	FI
Red-eyed Vireo (<i>V. olivaceus</i>)	FI
White-eyed Vireo (<i>V. griseus</i>)	FI
Northern Parula (<i>Parula americana</i>)	FI
Cerulean Warbler (<i>Dendroica cerulea</i>)	FI
Yellow-throated Warbler (<i>Dendroica dominica</i>)	FI
Ovenbird (<i>Seiurus aurocapillus</i>)	GI
Kentucky Warbler (<i>Oporornis formosus</i>)	GI
Common Yellowthroat (<i>Geothlypis trichas</i>)	FI
Yellow-breasted Chat (<i>Icteria virens</i>)	FI
Hooded Warbler (<i>Wilsonia citrina</i>)	FI
American Redstart (<i>Setophaga ruticilla</i>)	AI
House Sparrow (<i>Passer domesticus</i>)	O
Red-winged Blackbird (<i>Agelaius phoeniceus</i>)	O
Northern Oriole (<i>Icterus galbula</i>)	FI
Common Grackle (<i>Quiscalus quiscula</i>)	O
Brown-headed Cowbird (<i>Molothrus ater</i>)	O
Scarlet Tanager (<i>Piranga olivacea</i>)	FI
Northern Cardinal (<i>Cardinalis cardinalis</i>)	O
Rose-breasted Grosbeak (<i>Pheucticus ludovicianus</i>)	FI
Indigo Bunting (<i>Passerina cyanea</i>)	O
American Goldfinch (<i>Carduelis tristis</i>)	G
Rufous-sided Towhee (<i>Pipilo erythrophthalmus</i>)	O
Chipping Sparrow (<i>Spizella passerina</i>)	O
Field Sparrow (<i>S. pusilla</i>)	O
Song Sparrow (<i>Melospiza melodia</i>)	O

^a Trophic groups are omnivore (O), granivore (G), ground, bark, foliage, and aerial insectivore (GI, BI, FI, and AI), and nectarivore-frugivore (N-F).